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DESCRIPTION

OF THE

BARR AND STROUD 9-FOOT HORIZONTAL BASE SELF-CONTAINED RANGE FINDER

TYPE F. Q. 2

WITH INSTRUCTIONS FOR ITS USE
CARE, AND PRESERVATION

(*FOUR PLATES*)

MAY 18, 1911

WASHINGTON
GOVERNMENT PRINTING OFFICE
1917

UF850
B3U6

L.C.

UNIV. OF
CALIFORNIA

DESCRIPTION OF THE BARR AND STROUD 9-FOOT HORIZONTAL BASE SELF-CONTAINED RANGE FINDER, TYPE F. Q. 2, WITH INSTRUCTIONS FOR ITS USE.

GENERAL DESCRIPTION.

1. The Barr and Stroud range finder, type F. Q. 2 (9-foot base) is a self-reading range finder of internal base type. By coincidence of partial images the angle subtended by the base line at the target is measured. The telescope body contains separate optical systems in each half transmitting light to a common field eyepiece so that two partial images of the target may be seen simultaneously. Immediately under the field eyepiece is situated the finder eyepiece, with a large field of view, enabling the observer to locate the target quickly. Two highly important features of the instrument are the use therein (1) of a translatable deflecting prism which allows a large mechanical movement to measure the deviation of the beam of light and (2) a separating prism at the field eye lens which refracts through its two faces, upper and lower, just those rays incident from the right and left optical systems, respectively. The telescope body is mounted on a pedestal mount with seat attached and has a rotary motion about its horizontal axis. The mount has motion in azimuth.

TELESCOPE BODY.

(Plate II.)

2. *The telescope body* is a built-up cylinder about 9 feet long enlarged at both ends. A scale-illuminating window is at its center, and circular objective windows at each end are protected by rotatable end cover rings on which the sunshades are screwed. Gun-metal castings (the pentagonal prism carriers), within which the pentagonal holders are mounted, have conical forms and fit corresponding conical seats turned on the inside of the enlarged ends of the telescope body. The telescope body consists of a case and inner tube or frame.

3. The case is composed of drawn-brass tubes reenforced by gun-metal castings, assembled in such a way as to form for the greater length of the instrument a double envelope with an air space between the tubes. Upon the case are carried the bearing rings, eyepieces, the finder, the night lamp and push, the elevating rack, the working-head cover ring, and the necessary parts for carrying the inner tube or frame. Under the working-head cover ring are located the working and adjusting heads and sliders, viz, the deflecting head, the

365257

coincidence adjusting slider, the astigmatizer slider, and the halving adjusting head.

4. *Windows* of optical glass are provided at each end of the instrument. These windows are ground optically flat and parallel, and each is held in a holder secured to the tube by several screws. The glass used is of hard quality to permit of the windows being cleaned without fear of their being scratched if ordinary precautions are taken. (See par. 34.)

5. *A pentagonal prism carrier* fits into each of the end castings and has a carefully designed framework called the pentagonal holder for housing the pentagonal prism. An air space around the carrier protects the pentagonal prism from variations in temperature. To prevent distortion and motion, a central spring keeps the holder down on three spherical supports resting in corresponding counterbores on the holders. These three spherical supports are the ends of adjusting screws in bosses on the pentagonal prism carrier. The end caps are screwed on the end castings against the pentagonal prism carriers. By means of a V piece on the periphery of the carrier engaging a V notch on the end casting the proper location of the carrier is fixed. Unless the V piece and the notch are kept free from dirt and grit, the objective pentagonal prism is likely to be tilted and images in the field of view appear displaced vertically—that is, " halving " would be incorrect, or the images might appear slightly inclined to one another.

6. *The bearing rings* on which the telescope body rests when in its mountings are made in one with mechanical castings which act as connecting pieces between the tubes of the case. The tubes are soldered and pinned to these castings. Flanges on the left-hand bearing ring fit the cheeks of the rotating bracket on the mounting and prevent longitudinal movement of the telescope body.

7. *Eyepieces.*—At the center of the instrument a casting called the faceplate carries the two eyepieces for observation of the field of view and the scale, respectively, and a third eyepiece for the finder. It also carries a rubber face piece. The centers of the two eyepieces for the observation of the field of view and the scale are 2½ inches apart, and, since the scale eyepiece is oval, this eye distance accommodates all observers.

8. *Finder* (Pl. III).—Just below the field eyepiece is situated the finder eyepiece, provided with a focusing head. The finder eyepiece pertains to an optical system independent of the optical system of the range finder. The parts of this telescopic system consist of an objective below the scale-illuminating window, a double reflecting finder pentagonal prism, which reflects the light through an angle of 90°, and the finder prisms, which erect the image and deflect the pencil up into the eyepiece.

9. *Illuminating device.*—To the right of the finder window a lamp bracket is attached. A terminal plug fits into the side of the bracket; a blank plug is inserted for protection of the terminals by day. Inside the bracket is mounted an ebonite holder, which carries a 4½-volt lamp. By unscrewing the vulcanite knurled head at the end of the bracket the holder can be removed and the lamp itself pushed out. The lamp is used for illuminating the range scale at night. The lamp push is situated on the top of the outer tube and to the right of the right bearing ring. In the push is a spring contact, by means of which the lamp circuit is completed. For use with the lamp is a set of dry cells contained in a battery box. The current may be varied by a rheostat attached to the battery box. Cables with terminals connect the battery with the lamp holder.

10. *The working-head cover ring* is located within convenient reach of the observer's right hand. Its movement is limited by a stop screw, which serves also for locking the ring in the position in which the coincidence adjusting slider and halving adjusting head are covered, leaving the deflecting head and astigmatizer slider exposed. An index mark and suitable directions indicate the two positions of the ring, the one above referred to being the normal working position, and the other exposing also the coincidence adjusting slider and halving adjusting head.

11. *The deflecting head*, or roller, is mounted on the top of the tube at the right-hand side under the working-head cover ring, within convenient reach of the right hand of the observer. It is operated by the fingers of the right hand, the thumb being left free for working the lamp push. The deflecting head is used in measuring ranges and operates the scale drum and deflecting prism simultaneously by means of flexible couplings, a deflecting rod, and a gear shaft. A spring takes up backlash. When the head is rotated the spiral range scale is revolved past the scale index seen in the left eyepiece, and by means of the gearing referred to above the deflecting prism screw is operated simultaneously and the deflecting prism translated along the path of the beam of light, which enters the left end of the range finder.

12. *The coincidence adjusting slider* enables the scale to be moved independently of the deflecting prism. When the slider is moved to the left the coincidence gear shaft is slipped endwise so as to disengage the wheel which drives the deflecting prism screw. The driving pinion of the spiral drum is of sufficient length to remain always in mesh with the teeth of the drum, and thus when the slider is moved endwise the deflecting head drives the scale drum only, and not the deflecting prism screw, thus enabling the scale to be set at the known range after the images of the object in the field of view have been brought into exact coincidence.

13. *The astigmatizer slider*, by means of which points of light can be drawn out into streaks suitable for coincidence working, is located under the working-head cover ring on the under side of the tube. Two astigmatic lenses carried upon a pivoted lever are swung into the path of the two beams of light at the entrance to the central system of eyepiece prisms. Under normal conditions this slider is kept in the out position, in which case the astigmatizer is out of action. To astigmatize the object in the field of view the slider should be moved toward the middle of the instrument.

14. *The halving adjusting head* or roller is situated under the cover ring at the window side of the instrument and operates a central screwed shaft. This shaft engages an intermediate rod, the point of which bears on a housing for the halving glass, which is pivoted in the top of the inner tube. By means of this mechanism the halving glass is tilted, raising or lowering the image in the upper field of the right eyepiece. A spring attached to a guard ring about the inner tube takes up backlash.

15. *Inner tube.*—Within the case a cylindrical inner tube is held near its left end by a gimbal ring, and near its right end by a spherical bearing. The gimbal ring is supported horizontally by two gimbal pins. Circular cover plates protect the heads of these outer pins. The gimbal ring in turn supports the inner tube on two vertical gimbal pins fitted in a stiffening ring. This left suspension prevents sideways and rotational but not endwise movement of the tube. The right suspension is a spherical collar about the inner tube. This bearing constrains sideways movement only of the inner tube. The right suspension is supported by castings which carry pockets for the adjusting and working heads.

16. *The end reflectors*, which receive the beams of light entering the instrument, and which direct them toward the eyepiece prisms at the center of the instrument, are of the pentagonal (Prandl) type, the principal feature of which is that a movement of the prism in the plane of triangulation does not affect in any way the angular direction of the beam of light passing through the prisms. These prisms are mounted in a framework of special design, and to prevent distortion the frame is held down upon three points by means of a strong central spring. To prevent any movement of the framework it is firmly secured in position at the supports. The metal used for the framework has a coefficient of expansion equal to that of the glass used for the prisms; thus the effect of the temperature is diminished considerably.

17. *The optical system* (Pl. IV).—The optical parts of the instruments constitute two dependent telescopic systems; the group in the right-hand part forms an erect partial image in the upper field, the group in the left-hand part forms an erect partial image in the lower

field. The finder optical system mounted separately in the center casting has been described in paragraph 8. Above the inner tube, mounted separately in the center casting, are two rectangular scale prisms which reflect the image of the scale to the scale eyepiece.

The right optical system consists of a pentagonal prism, an objective, an equal magnification lens, a halving glass, an astimatizer lens, and the eyepiece prisms. A movement of the pentagonal prism about its principal axis does not affect the angular deflection of the incident pencil of light. The right-hand objective is of longer focal length than the left hand; and equal magnification lens corrects the difference. This lens is adjusted by the manufacturer and its position should not be disturbed. The halving glass is rotatable about a horizontal axis. Rotation of the glass produces a vertical displacement of the pencil of rays. The astigmatizer lens is of a different curvature in its vertical and horizontal planes so as to produce vertical distortion of the image. The eyepiece prisms are three in number and so arranged as to erect the image and to reflect the light up to the separating prism at such angles as to allow only those rays from the right objective to be refracted into the upper field, and only those rays from the left objective to be refracted into the lower field. The edge of the prism is, therefore, a clear separating line between the upper and lower field. The eyepiece is of modified Ramsden type and is common for both objectives.

The left telescopic system consists of a pentagonal prism, an objective, a deflecting prism, and also the eyepiece prisms. The deflecting prism is built of two prisms corrected for chromatic aberration. It has a longitudinal travel of about 4½ inches, corresponding to an actual scale length of about 22 inches. A longitudinal movement of the prism causes a lateral displacement of the ray corresponding to the angle subtended by the instrument at the target. The following values are approximate:

	Power.	Field.
		° ′
Range finder	30	1 30
Finder	10	4 00

MOUNT.

(Plate I.)

18. *The pedestal.*—A cast-iron pedestal carries at its upper end a steel spindle and a graduated disk. A flange on the spindle forms the lower member of a ball bearing, the upper member of which is a steel ring carried by a rotating sleeve which envelopes the upper two-third of the pedestal. The rotating sleeve is guided at its lower extremity by a gun-metal bushing working on a collar on the pedestal.

The seat bracket is bolted to the rotating sleeve and supports an adjustable seat. The disk protector and rotating bracket are one casting, which is bolted to the upper flanged end of the rotating sleeve. The rotating bracket supports the traversing and elevating gears of the range finder and carries the bearings for the telescope body.

19. *The traversing mechanism* is housed within the disk protector. Slow motion in azimuth is obtained by means of a traversing handwheel keyed to a worm shaft which is held in contact with the traversing worm wheel by an adjustable bearing. The worm wheel fits on the spindle and may be prevented from turning on the spindle by tightening the friction clutch, which forces the friction cone down against the conical seat on the upper inner surface of the worm wheel. When the friction clutch is released the instrument may be traversed freely without operation of the traversing handwheel.

20. *The azimuth disk* is an adjustable disk protected by the disk protector, and carries at its outer edge an azimuth scale. By means of a friction ring it is locked to a fixed disk which is keyed to the fixed steel spindle at the upper end of the pedestal. The knobs on these disks are used for slipping the adjustable disk about the fixed disk when it is desired to adjust for orientation without disturbing the position of the pedestal. The friction ring should be screwed down securely after the adjustment for orientation has been made. An index is engraved on the disk protector on the side away from the observer to enable him to read azimuths if desired.

21. *Elevating mechanism.*—The elevating gearing consists of a rack screwed to the case of the range finder, an elevating handwheel, and an elevating worm shaft mounted on the elevating bracket bolted to the left arm of the rotating bracket. The elevating worm shaft has a bearing at its two extremities in a shaft housing. The worm is keyed to the shaft. Longitudinal play of the shaft is taken up between a collar pinned to the shaft and the hub of the handwheel. The shaft housing is swiveled on a pivot on the elevating bracket. Three springs secured to the elevating bracket press against a stud in the shaft housing, taking up backlash in the gearing.

ACCESSORIES.

22. A box in the packing case contains the following parts and accessories:

2 screw-drivers.
2 screw wrenches, ½-inch and ¾-inch opening.
1 combination wrench.
1 pentagonal carrier starting pin.
2 sunshades.
1 rubber face piece.
Lamp leads.
1 battery box with 6 lamps.

MOUNTING.

23. The mount having been placed in position, the telescope body should be lifted carefully from its packing case by two men. It should be lowered gently into the journal bearings of the rotating bracket with the eyepieces toward the seat side of the mount and the deflecting head on top and at the right-hand side, care being taken to see that the elevating gearing engages properly. It should then be fastened in place and the elevating gear tested. In case a permanent shelter is provided for the range finder when in position the pedestal may be bolted down. This is not necessary, however, for satisfactory operation of the range finder. The packing case should be preserved and the case containing the accessories should be convenient to the range finder.

ADJUSTMENTS.

24. The adjustments to be made when necessary and checked frequently are:

(1) Revolving the seat to the accommodation of the observer.
(2) Orientation of the instrument.
(3) Focusing the eyepieces.
(4) Halving adjustment.
(5) Coincidence adjustment.
(6) Correcting for backlash in the traversing gear.

25. *Focusing.*—Special care should be exercised in the adjustment of the right eyepiece, as otherwise the eye may become tired and the accuracy of observations be affected. A careful setting of the finder eyepiece is not necessary.

26. *Orientation.*—As the smallest reading of the azimuth disk is 1° the instrument, therefore, is not adapted for accurate position finding, but the orientation should be sufficiently accurate for the purpose of identification of targets. Approximate orientation may be accomplished by a proper placing of the pedestal in position or the friction ring may be unscrewed, the azimuth disk turned to its proper setting, and the friction ring screwed down.

27. *Halving adjustment.*—An object viewed in the field eyepiece may appear partly duplicated or it may appear deficient; that is, a portion of the object may be missing. (Pl. IV.) A distortion of the inner tube in the vertical plane or a displacement of the objective pentagonal will cause a shifting of the partial images in opposite vertical directions. A large error of this kind will be noticed readily; a small one can be detected most easily on tapering objects of long vertical dimensions, as church spires and flag poles. To detect this error with certainty move the instrument in elevation

until the object is seen only in the lower field; then gradually alter the elevation till the image rises to the separating line. If halving is correct the top of the object will appear above the dividing line at the instant it disappears from the lower field. If the partial image appears too soon there is an error of duplication; if too late, an error of deficiency.

To correct the error the halving adjusting head which affects only the upper image is rotated downward to correct deficiency and upward to correct duplication. Check the adjustment to insure accuracy.

28. *Coincidence adjustment* (on objects at known ranges).—Bring the image of an object at known range into accurate alignment by means of a deflecting head. If the scale does not indicate the true range of the object, move the coincidence adjustment slider to the left to disengage the deflecting prism gear. Next set the scale to indicate the correct range by means of the deflecting head and move the coincidence adjustment slider to the "out" position to reengage the deflecting gear, touching the deflecting head gently to insure that the teeth of the spur wheels are engaged fully. Several readings should be taken on the same object to check the adjustment. In checking the coincident adjustment the left eye should be closed until the alignment of the image is satisfactory. The following method of checking this adjustment may be used: Move the deflecting head until the upper image is just perceptable to the right (or left) of the lower image and note the indication on the scale. Then move the deflecting head until the upper image appears in equal amount to the left (or right) and note the indication on the scale. The mean of the two scale indications should be the correct range of the object. The coincidence adjustment should be checked at two or more known ranges, one of which should be at as long range as good definition can be obtained. The errors due to faulty coincidence adjustment vary approximately as the square of the range. This adjustment should be made with great care, and, when possible, under favorable weather conditions.

29. *Coincidence adjustment* ("infinity" adjustment).—When there are no objects at known range from the instrument, or when the adjustment must be made at night and there are no fixed lights at known ranges, the moon or a bright star may be used. When adjusting upon the moon, its sharply defined edge should be used, and the separating line should cut the disk diametrically. The "infinity" indication of the scale, which is distinguished by a star-shaped mark, should be set opposite the pointer when the images have been brought into alignment. The astigmatizer is used in making this adjustment, or the range finder may be vibrated in

elevation to make the star appear as a streak of light. Several equally spaced marks are engraved on either side of the infinity division, and by means of these the accuracy of the adjustment may be tested as follows:

Take 10 readings, the scale reading in each case not being noted until after satisfactory alignment of the images has been obtained. Readings above infinity are recorded as + and those below as —. Taking 10 readings, for example, we might have—

+2
+2
+2
+1.5
+2
+ .5
+2
+2
+2
+1.5
Mean +1.7

The mean result shows that at true alignment the scale reading is +1.7 above the infinity mark. Put the images in true alignment for the infinity reading—that is, at +1.7 of the scale—then throw on the coincidence adjusting slider and move the scale back to read infinity without altering alignment of images. The following readings may be taken:

+1
+ .5
+ .5
+ .2
+ .2
+ .2
+ .2
+ .5
+ .5
+1
Mean + .48

An error of one scale division is equivalent to about 1 yard in 1,000, so that a mean error of this kind, one-half a dimension off, is sufficiently close.

30. *Correcting for backlash in the traversing gear.*—Backlash between worm and gear is taken up in the traversing gear by moving the lock nut in the slot toward the center of the instrument. The proper location of the nut in the slot is determined by securing easy motion and yet no play in the gearing. Longitudinal backlash is taken up by means of the square-headed screw on the shaft holder. (Pl. I.)

OPERATION.

31. The instrument is operated normally by one man, an observer. Before proceeding to the taking of ranges he should check carefully the adjustments described in paragraphs 27 and 28 or 29. To identify a target indicated to him by azimuth and description he releases the friction clutch (if not already released), directs the instrument to the azimuth indicated, and, by sighting over the eyepiece, verifies the approximate direction of the target. He identifies it by use of the finder, bringing the intersection of the finder cross wires on the portion of the target most suitable for observation. Then, by sighting through the right (field) eyepiece and working the deflecting head, he brings the two partial images of the target into alignment. When coincidence is exact he raises his fingers from the deflecting head and reads the range in the scale eyepiece, using his thumb to operate the push for illuminating the scale when making observations at night. Ranges taken when the lower image is just short of coincidence and just beyond coincidence serve as a maximum and minimum guide to correct reading. After some practice it will be found practicable to move the deflecting head between the two positions of equal amount of alignment in the two directions, and then to bring it midway between these positions. To insure the greatest accuracy, the alignment of the partial images should be made on a clearly defined portion of the target. The friction clutch and the worm gear operated by the traversing handwheel permit the observer to turn the range finder slowly in azimuth. When the friction clutch is loose, the observer can turn himself and the instrument freely in azimuth. Either method of turning may be used in following a target, but it will be found convenient to release the friction clutch when changing targets or in following a fast-moving target. The clutch may be tightened partially only when the two methods may be combined. The left hand is needed to operate the elevation handwheel from time to time to keep the separating line on the most favorable part of the target or to move it up and down slowly while coincidence is being obtained. This latter operation often assists in determining if coincidence is exact. More accurate ranges will be obtained if the observer is not required to take ranges at fixed intervals, as on the stroke of a bell, but is permitted to announce the range at approximately equal intervals of time and when he obtains satisfactory coincidence.

In using the astigmatizer at night, small lights, and not large luminous objects, will be the more satisfactory. (Pl. IV.) Proper precaution should always be taken to be sure that the partial images of the same light are made to coincide. This identification can be made by removing the astigmatizer for a moment and then placing it in the field, or by moving the astigmatizer halfway into the field, leaving the left half clear; then, by a slight motion in azimuth, the object can be astigmatized or not at will.

For night work, too, the three-lamp lead terminals should be attached to the battery, lamp push, and lamp, so that the scale can be illumined.

CARE AND PRESERVATION.

32. The range finder is an exceedingly delicate and sensitive instrument and should not be subjected to shocks, strains, neglect, or other ill usage. To care for the instrument properly, those responsible for it should familiarize themselves with the mechanical construction of the instrument, the functions of its various parts, the methods of adjusting, and the proper method of caring for mechanical and optical parts. (See also Pamphlet No. 1795, entitled "Instructions for the Care, Preservation, Repair, and Adjustment of Instruments for the Fire-Control System.")

33. The instrument should be kept in a dry place. Working parts should be oiled regularly and carefully with oil issued by the Ordnance Department for fire-control instruments. Proper care should be taken that no oil drops upon or reaches optical surfaces or other parts which do not require oiling.

34. The instrument requires regular cleaning by a responsible person. Only paper furnished by the Ordnance Department should be used for wiping the external faces of the glasses, and this paper should be free from dirt and grit and used for no other purpose.

35. Condensation of moisture on optical parts should be prevented. For removal of moisture, see instructions below under Dismantling and reassembling (par. 43).

36. When the instrument is not in use the end cover rings should be rotated to protect the objective windows from external injury, dust, or moisture.

37. The internal mechanism of the instrument is very delicate. No optical parts should be removed or readjusted except by a manufacturer properly equipped for delicate instrument work. To clean the internal optical parts, the inner tube must be removed. This work should be done only by a skilled mechanic on the order of the armament officer.

38. When not in use, the range finder should be kept covered.

39. To prevent burning out the lamps of the range finder, a high resistance should be thrown on at first and the resistance regulated to produce the intensity of illumination desired. The lamp should be in its receptacle at least 1½ turns.

40. In case the range finder is dismounted for storage or for shipment, it should be packed in the case provided so that no relative movement of parts can take place if the packing case is roughly handled. If stored, it should be kept dry and inspected frequently.

41. If proper shelter is not provided for the instrument in position for taking ranges, the telescope body should be removed when not in use and placed in its packing box and kept in a dry place close at hand, if possible. If the pedestal is not placed under cover also, it should be protected by a waterproof covering. The operation of setting up the instrument or of removing the telescope body for storage should be under the direct supervision of an officer in all cases.

42. *Dismantling and reassembling.*—The instrument should not be dismantled except when absolutely necessary, and then only by a competent person under proper orders. The disassembling of the inner tube is prohibited except as stated above.

43. To remove deposits of moisture from the inner optical parts, place the instrument in a dry place, unscrew the right and left hand caps, and cause dry air to circulate through the telescope tube. The end caps should be removed only on a dry day. When this method fails and the field of view is so cloudy as to interfere with the efficiency of the range finder, report should be made to the armament officer.

44. Dismantling must be done under cover. Tag each screw when disassembled to indicate its location. When the inner tube is removed it should be set up in two V blocks placed under the right and left supports.

To dismantle the instrument, proceed as follows:

(1) Unscrew the six fixing screws of the faceplate and remove it.

(2) Unscrew and remove the left end cap.

(3) Pry out and remove the left pentagonal prism carrier; near the top of the rim of the carrier is provided a hole into which the pentagonal carrier starting pin may be inserted. The carrier will be loosened with greater facility by giving a few gentle taps to the side of the outer tube near the carrier. Place the pentagonal in a protected place.

(4) Remove the two gimbal pins by first removing the circular cover plates beside the left bearing ring and then unscrewing the pins.

(5) Insert the hand in the faceplate aperture and push the inner tube out the left end of the case.

The finder optical parts, the scale prisms, the outer surface of the objective, and of the eyepiece field lenses can now be cleaned. If necessary, the finder optical parts can be removed by removing the cover plates on the underside of the central casting. Both surfaces of the halving glass and the equal magnification lens can be cleaned through aperatures in the frame. The deflecting prism must be translated opposite its aperture. To clean the astigmatizer lenses, remove the lever pivot screw from the underside of the eyepiece prism box. Let the lever drop down and withdraw the lens holders from the slots in the box. In replacing the astigmatizers special care should be taken not to reverse them.

45. *To reassemble the instrument* proceed in a reverse order to that described above. Then test the instrument carefully for errors of halving and coincidence adjustment.

46. The following instructions are added for the use of skilled instrument makers at shops fitted for delicate instrument work.

To dismantle the deflecting gear proceed as follows:

(1) Mark the position of the left objective. Remove the objective holder by unscrewing its two fixing screws.

(2) Mark the position of the diaphragms (about 4½ inches and 10 inches, respectively, from the left end of the tube). Insert a hook tool in the left end of the tube and withdraw the diaphragms.

(3) Remove the three screws near the right side of the left suspension and withdraw the whole of the coincidence gear—the deflecting screw, deflecting prism, inner bracket, and guide rod. Care should be taken not to lose the small plunger spring at the end of the deflecting screw.

47. *To remove the scale* proceed as follows:

(1) Unscrew and remove the screws which hold the aperture plate in position.

(2) Remove the vertical gimbal pins.

(3) Slacken off the two screws on the stiffening ring which forms a collar about the inner tube and remove the gimbal.

(4) Remove the bearing ring at the left end of the scale and the scale drum stop pin. Then withdraw the scale drum from its seating. No oil should be used on these parts.

48. *To remove the separating prism.*—If specks of dust appear in the field eyepiece they are due to deposits on the surfaces of the separating prism. Special care should be taken in selecting the best cloths for cleaning this prism as any scratches thereon are highly magnified by the field eyepiece. The separating prism holder readily slides out of the eyepiece prism box. The prisms and box can then be cleaned. No oil should be used on these parts.

49. *To replace the separating prism* the scale and deflecting prism should be set to read a range of about 7,000 yards. The prism holder is then slid back into its sleeve in the prism box. To test the adjustment of the separating prism note whether the two semicircles of light refracted to the eye form a continuous circle. If the upper half is to the right or left of the lower half rotate the prism till the separating line forms the horizontal diameter of a continuous circle of light. This adjustment is then correct. A positioning pin is fitted into the separating prism holder to locate its position and thus facilitate this adjustment.

NOMENCLATURE.

(Part I, Class II, Section 1.)

[The number of the plate on which the part appears is shown after each name.]

Adjustable bearings. (I.)
Adjusting screws. (II.)
Arms. (I.)
Astigmatizer lenses. (IV.)
Astigmatizer lever. (II.)
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FORM No. 1905.
Ed. Aug. 27—17—2,000.
14442-271 and 280.

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